Pioneering Fossil Finds from North Dakota

Clint A. Boyd

Paleontology has a long history in North Dakota that extends back before the establishment of the state. Although there are many different types of paleontologists that study many different topics about past life, at the most basic level all paleontological research is dependent upon the discovery, naming, and description of extinct species. Without that work, known as taxonomy, our knowledge of the history of life on Earth would be severely limited. The very first specimen that is discovered of a new species is referred to as the holotype. A holotype serves as a permanent reference point for all current and future paleontologists. For example, if you find a dinosaur fossil and you want to know if it is a new species, you first have to compare the new fossil to the holotypes of all of the known species of dinosaur and see if it matches any of them. If the new fossil is sufficiently different from all known species, then you can name a new species and create a new reference point. Holotypes are the most important fossils in the field of paleontology and there are special rules for ensuring their protection and accessibility to researchers to make sure we're not renaming the same species over and over again.

Ongoing work by NDGS paleontologist Jeff Person has so far identified over 120 different species of extinct plants and animals that were first described based on fossils found in North Dakota. Those discoveries highlight the important role North Dakota continues to play in helping us understand the history of past life on Earth.

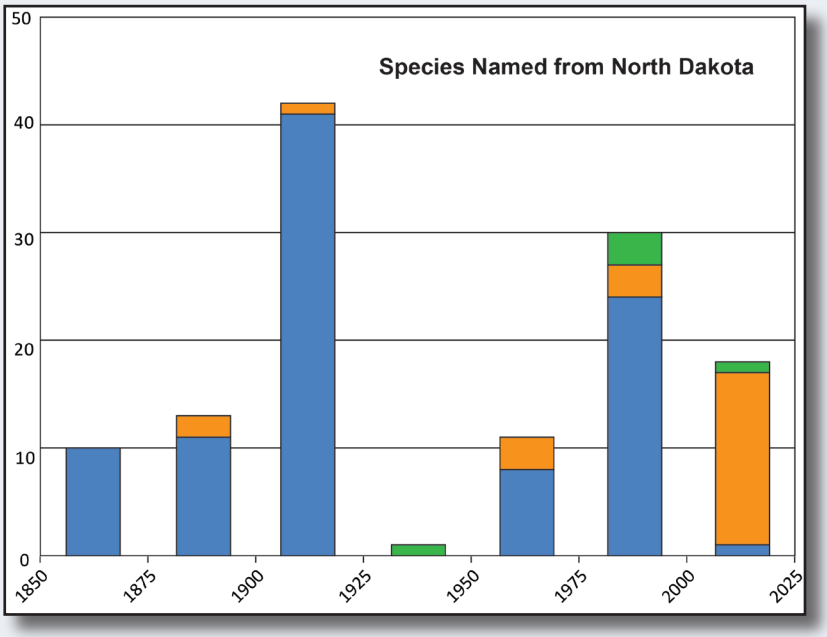

Figure 1. The number of new species found in North Dakota since 1850. Color key: blue, invertebrate species; green, plant species; orange, vertebrate species.

Early Work

Before the state of North Dakota officially existed, the geology and paleontology of the region was being intensely studied. In fact, the first new species from this region was described in 1856 (Meek and Hayden, 1856) and a total of 23 species were named during the ensuing 33 years before North Dakota officially became a state (fig. 1). Most of that work was done by Ferdinand Hayden and Fielding Meek, geologists who traveled through present day western North Dakota, which at that time was a part of Nebraska Territory, surveying the geology of the region and constructing a robust fossil collection from the rocks they encountered. Between 1856 and 1876 they coauthored a series of papers describing more than 20 new species of invertebrates (mostly clams and snails) from Cretaceous (Hell Creek and Fox Hills Formations) and Paleocene (Cannonball Formation) rocks (e.g., Meek and Hayden, 1856; Meek, 1876). That's right, decades before the now iconic dinosaurs *Triceratops* (named in 1889) and *Tyrannosaurus* (named in 1905) were known, clams and snails from those same rocks were being studied and described from North Dakota. After all, it was far easier at that time to quickly collect dozens of snail and clam fossils and transport them by wagon on your journey through the region until your return to the east coast than it was to do the same with even a single dinosaur skeleton.

Another important early paleontological discovery in North Dakota was accomplished by famed paleontologist Edward D. Cope, one half of the famous Cope and Marsh bone wars that raged across western North America in the latter half of the 19th century. Charles A. White, at that time surveying portions of Dakota Territory for the United States Geological Survey, discovered some thinly bedded shales near the top of Sentinel Butte in modern day Golden Valley County, North Dakota (White, 1883). Upon splitting open several slabs of that shale he discovered a few partial to nearly complete skeletons of a small fish (fig. 2). He saved some of the more complete specimens and sent them to Edward Cope for identification. Cope realized that not only were these a completely new type of fish, but based on the specimens he was sent there were actually two closely related species present. The first he named *Plioplarchus whitei*, in honor of Charles White for discovering the fossils, and the other was named *Plioplarchus sexspinosus* (Cope, 1883). Later work by NDGS geologists would confirm these rocks were deposited during the Eocene, about 34 million years ago (Murphy et al., 1993). These two species of fish were the first vertebrate species (animals with a backbone) named from North Dakota, and to this day fossils of those species have not been found anywhere else in North Dakota.

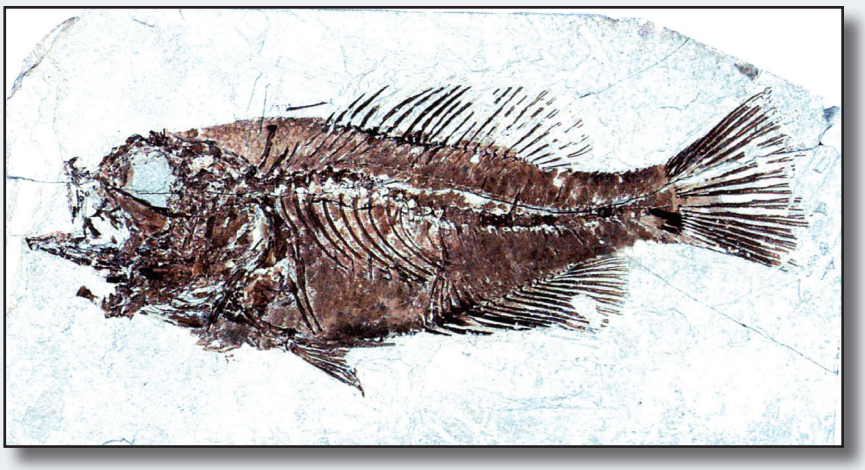

Figure 2. A well-preserved specimen of the Eocene fish *Plioplarcus sexspinosus* (NDGS 71) collected in Golden Valley County, North Dakota.

mammals preserved in the state (fig. 1), a group that together are referred to as vertebrates. A portion of that work is focused on the use of a method known as screenwashing, a process where rocks are placed within a wooden box that has a fine screen on the bottom and are left to soak in water for hours or days. During that time the rock falls apart and the fine grains of mud and sand fall through the screen, but any tiny fossils preserved in the rock are left behind in the box (see Person [2015] for more details on this methodology). This is a much more efficient method of discovering tiny fossils (those only a fraction of an inch in size) than the standard practice of crawling around on the surface of rocks looking for fossils that have weathered out naturally. Given how difficult it is to find and collect such tiny fossils, it is not surprising that many of the animals discovered through this process end up representing new species.

Fossils from Drill Cores

The second highest peak in the naming of new species from North Dakota came during the end of the 20th century (fig. 1: 1976-2000). That increase was largely the result of a set of studies published in 1992 that examined invertebrate fossils from rock formations situated entirely beneath the surface of North Dakota (Caramanica, 1992; Grenda, 1992; Lobdell, 1992). How does one study rocks that are completely buried? By examining drill cores like those housed at the North Dakota Geological Survey's Wilson M. Laird Core and Sample Library on the campus of the University of North Dakota. Most people don't think about drill cores when they think of places to find fossils, but it is not uncommon to find partial or complete invertebrate fossils in drill cores (fig. 3). In this case, new species of corals, bryozoans, and one species of crustacean (shrimp-like animal) were described from several Paleozoic rock formations dating back over 250 million years ago.

Studying fossils in drill cores isn't just done to learn about past life. Fossils can provide important insight into the age of the rocks and the environment in which they formed. That information is useful when determining which parts of a rock formation are more or less likely to contain resources like oil and gas deposits. Fossils are also useful for comparing drill cores from different geographic areas because many species only lived during very specific time periods. For example, if you find fossils from Species A in part of a drill core from one well, and also find Species A in part of a drill core from a second well many miles away, you can make the interpretation that those two rocks likely formed at the same time, even if the type of rock is completely different (e.g., limestone versus shale). These facts highlight the potential financial impact that studying and understanding the fossils preserved in these rocks can have for North Dakota.

21st Century Changes

As the 20th century gave way to the 21st century, the focus of paleontological research in North Dakota shifted away from invertebrates and was focused more heavily towards the unique species of sharks, rays, fish, turtles, crocodylians, birds, and

Over the past few years NDGS paleontologists have been screenwashing large amounts of rock from several locations across North Dakota, but the focus has been on rocks of the Oligocene Brule Formation exposed in Stark County. Those efforts have been highly successful, recovering fossils from seven new species of small mammals that were described over the last three years (2018-2020). One of the most scientifically significant of those new discoveries was a tiny upper jawbone from a new species of bat, named *Quinetia frigidaria* (fig. 4: Czaplewski et al., 2019). The fossil record of bats from this time period in North America is very poor, with only a single other species described, so the

Figure 3. Rugose coral and brachiopod shells are visible in core from the Mississippian Madison Group in the Socony – Vacuum Oil Company's Angus Kennedy well in northern Dunn County. Core depth = 9,304 ft.

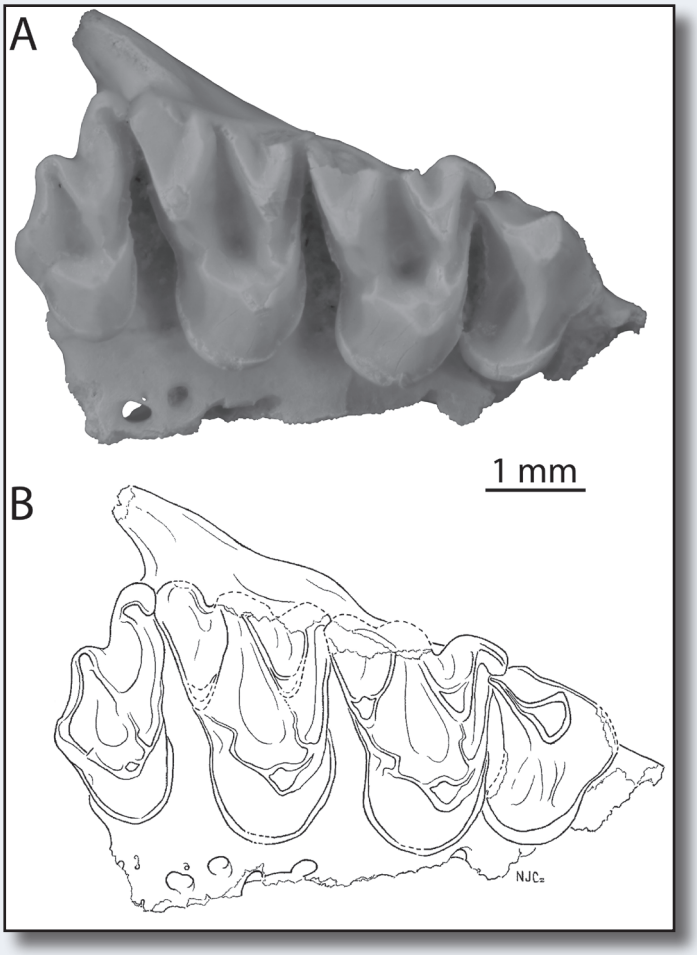

Figure 4. Photograph (A) and illustration (B) of the holotype right upper jaw of the extinct bat *Quinetia frigidaria* (NDGS 1691) from the Oligocene Brule Formation of North Dakota. Forward is to the right, the cheek is situated towards the top of the image, and the inside of the mouth would be along the bottom edge.

Figure 5. A life reconstruction of the tiny marsupial *Copedelphys superstes* from the Oligocene Brule Formation of North Dakota snacking on a hackberry. This discovery was the youngest occurrence of *Copedelphys* in the world, just prior to its extinction about 30 million years ago.

discovery of this fossil provides important information about the early evolution of bats. A second important discovery was several teeth and partial jaws from a new species of the mouse-sized marsupial *Copedelphys* (fig. 5). *Copedelphys* first appears in the fossil record during the Eocene in North America, about 37 million years ago, and the last species, *Copedelphys stevensoni* was thought to go extinct about 31 million years ago (Korth, 2018). The fossils from North Dakota revealed that a new species, *Copedelphys superstes*, lived in this area until about 30 million years ago, indicating that this tiny marsupial survived longer in North Dakota than elsewhere in North America, before eventually going extinct (Korth et al., 2020).

In Honor of Marmarth

There is one final species first described in North Dakota that I would like to mention here. The small city of Marmarth in Slope County is situated amongst outcrops of the fossil-rich Hell Creek Formation. Some of the best and most impressive fossils found in North Dakota were discovered in the area around Marmarth, including the exquisitely preserved dinosaur mummy 'Dakota.' That area is also one of the best areas in the world to study how the Cretaceous-Paleogene extinction impacted plant and animal life, including the extinction of the non-avian dinosaurs. As a result, every summer paleontologists from around the world travel to Marmarth to study these rocks and the fossils they contain. Although the Hell Creek Formation is best known for its dinosaur fossils, well-preserved fossil plants are also commonly found in those rocks, providing insight into the environment in which those dinosaurs and other animals lived. In 1996, paleontologist Kirk Johnson named a new type of extinct plant after the town: *Marmarthia* (fig. 6: Johnson, 1996). Several species of this plant genus are now recognized from the Hell Creek Formation. One of those species, *Marmarthia pearsonii*, is named after North

Figure 6. A specimen of the fossilized leaf *Marmarthia* (NDGS 1484) from the Cretaceous Hell Creek Formation of North Dakota.

Dakota's own Dean Pearson from the Pioneer Trails Regional Museum in Bowman in honor of his work on the paleontology of North Dakota, especially in the Marmarth area. Unfortunately, you can't add *Marmarthia* to your garden at home because it went extinct along with the non-avian dinosaurs at the end of the Cretaceous.

More New Species on the Horizon

So after over 150 years of studying the fossils of North Dakota have we described all the extinct species that used to live here? Not even close! Several additional new species from North Dakota are currently undergoing description and should be published within the next few years, and every year we make new discoveries that teach us more about the unique plants and animals from North Dakota's past. Many of the most important specimens discovered by the NDGS Paleontology Program over the past few years were found during the annual Public Fossil Digs, where members of the public join our paleontologists in the field to find and preserve North Dakota's prehistoric past. Foremost among those discoveries is a likely new species of mosasaur, a carnivorous marine reptile from the Cretaceous Pierre Formation that was collected over the past few years on our Pembina Public Fossil Dig (fig. 7: Boyd, 2017). North Dakota remains one of the best places in North America to find fossils and the North Dakota Geological Survey's Paleontology Program will continue working to preserve North Dakota's prehistoric heritage for future generations and bringing all these great discoveries to the attention of the entire world.

Figure 7. Participants on the Pembina Public Fossil Dig in 2017 working to uncover more bones of our new species of mosasaur from the Cretaceous Pierre Shale. Beverly Lake (Minnesota) is on the left, and Robert Roman (Florida) is on the right.

References

Boyd, C. A., 2017, A new addition to the Cretaceous seaway of North Dakota: Geo News, v. 44, no. 1, p. 20-23.

Caramanica, F. P., 1992, Ordovician Corals of the Red River – Stony Mountain Province, in Erickson, J. M., and Hoganson, J.W., eds., Frank D. Holland, Jr. Symposium, Proceedings: North Dakota Geological Survey Miscellaneous Series, 76, p. 23-97.

Cope, E. D., 1883, On a new extinct genus and species of Percidae from Dakota Territory: American Journal of Science, 3rd Series, v. 25, p. 414-416.

Czaplewski, N. J., Person, J., Boyd, C. A., Emry, R. J., 2019, A new species of bat (Chiroptera: Vespertilionidae) from the early Oligocene global cooling period, Brule Formation, North Dakota, USA: Palaeo Vertebrata, 42:e2.

Grenda, J. C., 1992, *Tylerocaris hollandi* n. gen., n. sp., (Malacostraco: Tealliocarididae) from the Tyler Formation (Pennsylvanian) of North Dakota, in Erickson, J. M., and Hoganson, J.W., eds., Frank D. Holland, Jr. Symposium, Proceedings: North Dakota Geological Survey Miscellaneous Series, 76, p. 193-197.

Johnson, K. R., 1996, Description of seven common fossil leaf species from the Hell Creek Formation (Upper Cretaceous: Upper Maastrichtian) North Dakota, South Dakota, Montana: Proceedings of the Denver Museum of Natural History series 3, no. 12, p. 1-47.

Korth, W. W., 2018, Review of the marsupials (Mammalia: Metatheria) from the late Paleogene (Chadronian-Arikareean: late Eocene-late Oligocene) of North America: Palaontologische Zeitschrift, v. 92, p. 499-523.

Korth, W. W., Boyd, C. A., Emry, R. J., and Person, J. J., 2020, Marsupials (Mammalia, Metatheria) from the Brule Formation (Whitneyan, Oligocene) North Dakota: Journal of Paleontology, p. 1-12. doi: 10.1017/jpa.2020.41.

Lobdell, F. K., 1992, Arthrostylidae (Bryozoa: Cryptostomata) from the Gunn Member, Stony Mountain Formation (Upper Ordovician), North Dakota and Manitoba, in Erickson, J. M., and Hoganson, J.W., eds., Frank D. Holland, Jr. Symposium, Proceedings: North Dakota Geological Survey Miscellaneous Series, 76, p. 99-135.

Meek, F. B., 1876, A report on the Cretaceous and Tertiary fossils of the upper Missouri country: Report of the United States Geological and Geographical Surveys of the Territories, 9, p. 1-629.

Meek, F. B., and Hayden, F. V., 1856, Descriptions of twenty-eight new species of Acephala and one Gasteropod [sic] from the Cretaceous formations of Nebraska Territory: Proceedings of the Academy of Natural Sciences of Philadelphia, 8, p. 81-87.

Murphy, E. C., Hoganson, J. W., and Forsman, N. F., 1993, The Chadron, Brule, and Arikaree formations in North Dakota – the buttes of southwestern North Dakota: North Dakota Geological Survey Report of Investigations, 96, p. 1-114.

Person, J. J., 2015, Microfossils: Geo News. v. 42, no. 2 p. 6-9.

White, C. A., 1883, On the existence of a deposit on northeastern Montana and northwestern Dakota that is possibly equivalent with the Green River Group: American Journal of Science, 3rd Series, v. 25, p. 411-414.